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JC961 U.S. PTO

03-25-02

10089006 MAR 21 2002

FORM PTO-1390
(REV. 1-99)

U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE ATTORNEYS & AGENTS

TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371

U.S. APPLICATION NO. (known as "PCT")

10/089006

INTERNATIONAL APPLICATION NO.

PCT/GB00/03615

INTERNATIONAL FILING DATE

21 September 2000

PRIORITY DATE CLAIMED

21 September 1999

TITLE OF INVENTION

PLOUGHS

APPLICANT(S) FOR DO/EO/US

GRINSTED, Timothy William

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 19(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
 - a. ☒ is transmitted herewith (required only if not transmitted by the International Bureau)
 - b. ☒ has been transmitted by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US)
6. ☐ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
 - a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau)
 - b. ☐ have been transmitted by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☐ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern other document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A **FIRST** preliminary amendment.
☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
14. ☐ A substitute specification.
15. ☐ A change of power of attorney and/or address letter.

16. ☒ Other items or information: 1. Int'l Search Report by European Patent Office

"Express Mail" mailing label number EU 340064634 US


Date of Deposit March 21, 2002

I hereby certify that this paper is being deposited with the U.S. Postal Service "Express Mail-Post Office to Addressee" service under 37 C.F.R. 1.10 on the date indicated above and is addressed to: Hon. Commissioner of Patents and Trademarks, Washington, D. C. 20231.

Edwin D. Schindler, Reg. No. 31,459

March 21, 2002

Date

17. <input checked="" type="checkbox"/> The following fees are submitted:				CALCULATIONS		PTO USE ONLY
Basic National Fee (37 CFR 1.492(a)(1)-(5)): \$890.00 Search Report has been prepared by the EPO or JPO..... \$890.00				10/089006		
International preliminary examination fee paid to USPTO (37 CFR 1.482) \$640.00 No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2)).. \$710.00						
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO..... \$950.00						
International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4)..... \$90.00						
ENTER APPROPRIATE BASIC FEE AMOUNT =						\$ 890.00
Surcharge of \$130.00 for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(e)).				\$ -0-		
Claims	Number Filed	Number Extra	Rate			
Total 17 Claims	17 -20 =	-0-	X \$22.00	\$ -0-		
Independent Claims	4 -3 =	1	X \$24.00	\$ 84.00		
Multiple dependent claims(s) (if applicable)			+ \$230.00	\$ -0-		
TOTAL OF ABOVE CALCULATIONS =				\$ 974.00		
Reduction by 1/2 for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 CFR 1.9, 1.27, 1.28).				\$ -0-		
SUBTOTAL =				\$ 974.00		
Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				+ \$ -0-		
TOTAL NATIONAL FEE =				\$ 974.00		
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property +				\$ -0-		
TOTAL FEES ENCLOSED =				\$ 974.00		
				Amount to be:		
				refunded \$		
				charged \$		
a. <input checked="" type="checkbox"/> A check in the amount of \$**974.00 to cover the above fees is enclosed.						
b. <input type="checkbox"/> Please charge my Deposit Account No. _____ in the amount of \$ _____ to cover the above fees. A duplicate copy of this sheet is enclosed.						
c. <input checked="" type="checkbox"/> The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 19-0450. A duplicate copy of this sheet is enclosed.						
NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.						
SEND ALL CORRESPONDENCE TO: Edwin D. Schindler Five Hirsch Avenue P. O. Box 966 Coram, New York 11727-0966				 SIGNATURE Edwin D. Schindler NAME 31,459 REGISTRATION NUMBER		

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICANT: TIMOTHY W. GRINSTED ART UNIT:
SERIAL NO.: 10/ EXAMINER:
FILED:
P.C.T. APPLICATION NO.: PCT/GB00/03615
P.C.T. INTERNATIONAL FILING DATE: SEPTEMBER 21, 2000
EARLIEST PRIORITY CLAIM: SEPTEMBER 21, 1999
TITLE: PLOUGHS

PRELIMINARY AMENDMENT

Hon. Commissioner for Patents
United States Patent and Trademark Office
Box PCT
Washington, D. C. 20231

Dear Sir:

Prior to an examination on the merits of the above-identified patent application, please amend the above-identified application as follows:

IN THE ABSTRACT OF THE DISCLOSURE

Please use the accompanying Abstract of the Disclosure,

"Express Mail" mailing label number EU 340064634 US
Date of Deposit March 21, 2002

I hereby certify that this paper is being deposited with the U.S. Postal Service "Express Mail - Post Office to Addressee" service under 37 C.F.R. §1.10 on the date indicated above and is addressed to: Hon. Commissioner for Patents, United States Patent and Trademark Office, Washington, D. C. 20231.


Edwin D. Schindler, Reg. No. 31,459

March 21, 2002
Date

which is contained on a separate sheet of paper, as required by 37 C.F.R. §1.72(b), as the Abstract for the instant patent application.

IN THE CLAIMS

Please amend the claims of the above-identified P.C.T. patent application (which were not amended during the Chapter II P.C.T. international phase), as follows:

3. (Amended) A plough according to claim 1 in which the tow rope attachment mechanism comprises a bridle having two bridle limbs terminating at one end at the tow rope retention point and at the other at respective bridle limb retention points.

8. (Amended) A plough according to claim 3 in which the tow rope attachment mechanism is adapted to enable movement of the bridle limb retention points relative to the plough from respective towing positions to¹ respective lifting positions at which the bridle can be used to lift the plough in a substantially level attitude.

9. (Amended) A plough according to claim 3 in which the tow rope attachment mechanism is adapted to enable the said adjustment of the position of the tow rope retention point relative to the plough by adjustment of the relative length of the bridle limits.

[illegible]

12. (Amended) A plough according to claim 11 in which the steerable soil-engaging fins are carried by one or more supporting skids.

REMARKS

Prior to an examination on the merits of the above-identified patent application, please enter the foregoing amendments.

Claims 1-17 are pending in the above-identified patent application. Claims 1, 11, 16 and 17 are single claims presented in independent form.

The present application represents the U.S. National Phase of P.C.T. Application No. PCT/GB00/03615, filed September 21, 2000, and claiming foreign priority on the basis of Applicant's corresponding United Kingdom patent application, filed September 21, 1999.

By the present amendment, dependent Claims 3, 8, 9 and 12 have been amended in order to remove the multiple dependencies therefrom.

A substitute Abstract of the Disclosure, on a separate sheet of paper, as required by 37 C.F.R. §1.72(b), is also enclosed.

A "marked-up" version of the claim amendments being

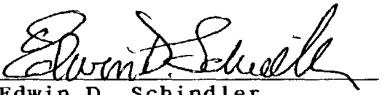
entered is attached to this Preliminary Amendment.

The application is now in condition for a full examination on the merits.

Accordingly, an early examination on the merits and allowance are, therefore, respectfully requested and earnestly solicited.

Respectfully submitted,

TIMOTHY W. GRINSTED

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March 21, 2002

$$\begin{aligned} & \left(\frac{\partial}{\partial t} + \vec{v} \cdot \nabla \right) \rho = -\rho \nabla \cdot \vec{v}, \\ & \left(\frac{\partial}{\partial t} + \vec{v} \cdot \nabla \right) \vec{v} = -\frac{1}{\rho} \nabla p + \nu \nabla^2 \vec{v}, \\ & \left(\frac{\partial}{\partial t} + \vec{v} \cdot \nabla \right) T = \kappa \nabla^2 T, \\ & \left(\frac{\partial}{\partial t} + \vec{v} \cdot \nabla \right) c_i = D_i \nabla^2 c_i, \end{aligned}$$

A marine plough includes twin, complementary steering mechanisms, one or more soil-engaging fins, which are able to be steered, and a tow rope attachment mechanism that enables adjustment of the position of the tow rope retention point relative to the plough. This alters the position at which the line of a tow rope crosses the longitudinal axis of the plough, so that the plough can operate at offset tow positions. The tow rope attachment mechanism includes a bridle having two bridle limbs terminating at respective bridle limb retention points. The adjustment of the position of the tow rope retention point relative to the plough is done by moving the bridle rope retention points or adjusting the relative length of the bridle limbs. The bridle limb retention points can be moved, using cylinders, from towing positions to lifting positions at which the tow bridle can be used to lift plough in a substantially level attitude. The soil-engaging fins are carried by supporting skids, in turn carried by a steering member able to be pivoted relative to the plough about a substantially vertical axis. Ploughing depth can be adjusted by altering the vertical distance between the skids and the steering member.

VERSION OF AMENDMENTS WITH MARKINGS TO SHOW CHANGES MADE
(Dated March 21, 2002)

IN THE CLAIMS

Please amend the claims of the above-identified P.C.T. patent application (which were not amended during the Chapter II P.C.T. international phase), as follows:

3. (Amended) A plough according to claim 1 [or claim 2] in which the tow rope attachment mechanism comprises a bridle having two bridle limbs terminating at one end at the tow rope retention point and at the other at respective bridle limb retention points.

8. (Amended) A plough according to [any one of claims 3-7] claim 3 in which the tow rope attachment mechanism is adapted to enable movement of the bridle limb retention points relative to the plough from respective towing positions to respective lifting positions at which the bridle can be used to lift the plough in a substantially level attitude.

9. (Amended) A plough according to [any one of claims 3-8] claim 3 in which the tow rope attachment mechanism is adapted to enable the said adjustment of the position of the tow rope retention point relative to the plough by adjustment of the relative length of the bridle limits.

12. (Amended) A plough according to [any preceding] claim 11 in which the steerable soil-engaging fins are carried by one or more supporting skids.

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PLOUGHS

BACKGROUND TO THE INVENTION

This invention relates to ploughs, particularly those for burial of cables and pipelines
5 in the bed of the sea or other water.

Ploughs are well-known for use in protecting cable and pipelines underwater. The cables or pipelines are buried to protect them from damage by, for example, fishing equipment or anchors. Typically these ploughs are towed via a towrope by a vessel on the surface of the water, but may be towed by an underwater tractor. Such ploughs are fitted with a soil-engaging share that is shaped to dig into the seabed under the action of the towing force and produce a trench into which the cable or pipe is placed. The ploughs usually lay the cable or pipeline in the trench. The invention applies to all types of plough.

15 Hitherto, such ploughs have often been fitted with a steering system that operates by exerting transverse forces on the tow wire and thus generating couples on the plough that alter the direction of travel of the plough. Some of these ploughs are fitted with a bridle and crank mechanism to minimise the forces required to steer the plough. Such
20 ploughs are described in patent EP 0185422. In some applications this mechanism can be lifted into an upright position to move the two wire attachment points to a position above the plough so that the same wire can lift the plough in a level attitude.

25 This method of steering a plough has the disadvantage that the direction of travel of the plough is affected by changes in the tow rope direction together with any side forces, for example from side slopes that the plough may be traversing. The plough or a part of it is effectively dragged sideways across the seabed.

Ploughs that steer by means of steerable fins attached to skids that support the front
30 of the plough are also known. Such a plough is shown in EP 0010915. This design
overcomes the disadvantage of the first design in that the plough can be steered

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relative to the seabed without being dragged across the seabed. The mechanism works in the same way as the steering in a car. To minimise the steering forces required from the steerable fins on the skids, the tow rope is connected near to the back of the plough, or to a towing mechanism with a single tow point slidably
5 mounted on a curved arm extending laterally from the main plough beam, to give the effect of towing from near the back - see EP 0010915.

This method of steering has the disadvantage that without such a force minimisation towing mechanism the steering angles relative to the tow rope are limited. Also the
10 force minimisation towing mechanism described would be difficult to adapt for larger angles of steering because of the requirement for a mechanism of greater size.

A further feature of these ploughs is the need for the towing mechanism to pass over the top of the plough and therefore also, where applicable, the cable or pipeline
15 passage through the plough. This prevents or limits one's ability to mount other equipment, particularly if the tow points must be transferred to a lifting position.

SUMMARY OF THE INVENTION

According to a first aspect of the present invention, there is provided a plough
20 comprising a plough share, one or more steerable soil-engaging fins and a tow rope attachment mechanism having a tow rope retention point, the tow rope attachment mechanism being adapted to enable adjustment of the position of the tow rope retention point relative to the plough, thereby altering the position at which the line
25 of a tow rope retained by the tow rope retention point crosses the longitudinal axis of the plough, so that the plough can operate at a range of offset tow positions. The tow rope attachment mechanism may comprise releasable mechanical locking means for preventing the said adjustment from taking place.

Preferably, the tow rope attachment mechanism comprises a bridle having two bridle
30 limbs terminating at one end at the tow rope retention point and at the other at respective bridle limb retention points. The tow rope attachment mechanism may be

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adapted to enable the said adjustment of the position of the tow rope retention point relative to the plough by movement of the bridle rope retention points. For example, the tow rope attachment mechanism may include a pair of arms, each pivotable relative to the plough about a substantially vertical axis at its inboard end and
5 providing a respective bridle rope attachment point at its outboard end. The pivotable arms may extend substantially laterally with respect to the plough or substantially longitudinally with respect to the plough.

Preferably, the tow rope attachment mechanism is adapted to enable movement of the
10 bridle limb retention points relative to the plough from respective towing positions to respective lifting positions at which the bridle can be used to lift the plough in a substantially level attitude.

As an alternative to the above, the tow rope attachment mechanism may be adapted
15 to enable the said adjustment of the position of the tow rope retention point relative to the plough by adjustment of the relative length of the bridle limbs. For example, the bridle limb retention points may comprise guides through which the bridle limbs pass and the plough may further comprise a pair of movable bridle limb attachment points to which the bridle limbs are attached. According to a second aspect of the
20 present invention, there is provided a plough comprising a plough share and a tow rope attachment mechanism having a pair of bridle limb retention points, the tow rope attachment mechanism being adapted to enable adjustment of the relative length of a pair of bridle limbs retained by the bridle limb retention points, thereby altering the position at which the line of a tow rope connected to the bridle limbs crosses the
25 longitudinal axis of the plough, so that the plough can operate at a range of offset tow positions, in which the bridle limb retention points comprise guides through which the bridle limbs pass, and further comprising a pair of movable bridle limb attachment points to which the bridle limbs are attached.

30 Preferably, the steerable soil-engaging fins are carried by one or more supporting skids. The supporting skids are themselves preferably carried by a steering member

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pivotable relative to the plough about a substantially vertical axis. Means may be provided for adjusting ploughing depth by altering the vertical distance between the skids and the steering member.

- 5 Where there are two or more skids, the vertical distance between one such skid and the steering member may be alterable independently of the vertical distance between another such skid and the steering member.

- 10 A third aspect of the present invention provides a plough comprising a plough share and a tow rope attachment mechanism having a pair of bridle limb attachment points, the tow rope attachment mechanism being adapted to enable movement of the bridle limb attachment points relative to the plough, thereby altering the position at which the line of a tow rope connected to the bridle limbs crosses the longitudinal axis of the plough, so that the plough can operate at a range of offset tow positions, and
15 further comprising a mechanical linkage between the bridle limb attachment points such that movement of one bridle limb attachment point in one sense is accompanied by movement of the other in the other sense.

- 20 A fourth and related aspect of the invention provides a plough comprising a plough share and a tow rope attachment mechanism having a pair of bridle limbs, the tow rope attachment mechanism being adapted to enable adjustment of the relative length of the bridle limbs, thereby altering the position at which the line of a tow rope connected to the bridle limbs crosses the longitudinal axis of the plough, so that the plough can operate at a range of offset tow positions, and further comprising a
25 mechanical linkage between the bridle limbs such that lengthening of one bridle limb is accompanied by shortening of the other.

BRIEF DESCRIPTION OF THE DRAWINGS

- 30 The present invention will now be described by way of example with reference to the accompanying drawings, in which:

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Figure 1 shows in elevation a typical plough in operating position in the seabed;

Figure 2 shows a plan view of the plough of figure 1;

Figure 3 shows a plan view of the plough of figures 1 and 2 with the skids
5 angled to steer the plough to the left;

Figure 4 shows a plan view of the plough of figures 1 and 2 with the towing mechanism moved to accommodate an offset tow position;

Figure 5 shows an elevation of the plough of figures 1 and 2 with the tow rope in lifting position;

10 Figures 6 and 7 show plan views of ploughs fitted with alternative methods of steering the skids;

Figures 8 and 9 show plan views of a plough fitted with an alternative method of adjusting the towing bridle in, respectively, an extended tow position and on offset tow position;

15 Figures 10 and 11 show elevations of the plough of figures 8 and 9 from the front of the plough with the towing bridle in an upright position; and

Figures 12-15 show plan views of alternative chassis and bridle arrangements (steerable skids and other details omitted for clarity in the case of figures 12 and 13).

Figures 16 and 17 show two passive bridle adjustment mechanisms.
20

DETAILED DESCRIPTION

Referring to the figures 1 to 5, a seabed cable plough is made up of an elongate chassis 1, a share 3 at the rear of plough 10, and support skids (2 and 4) two each at the front and rear respectively. The front skids 2 support the plough on the seabed 6
25 and are adjustable by hydraulic rams 42 in figures 3 and 5) to set the trenching depth of the plough. The share 3 penetrates the seabed as the plough is towed by a ship (not shown) via a towrope 5. Cable 7 to be buried enters the front of the plough at bellmouth 12 and exits underground at the back of the plough 8. Rear spaced skids 4 support the back of the plough when operating in very soft seabed soils. The plough
30 may be fitted with a control and monitoring system and a hydraulic power pack, typically located on top of the plough at 45, allowing the operators on the ship to

operate it effectively by controlling the position of the hydraulic rams. Alternative adjustment mechanisms to rams can be used although rams are particularly suitable when the plough is used in the submarine environment.

- 5 Assemblies 28 at each side of the chassis 1 are rotatable by hydraulic rams 29 about a horizontal axis at pivot 30 and support tow adjustment mechanism 14 comprising, in this embodiment, hydraulic rams 27 sidewardly, extending pivotable arms 25 to which tow bridle 9 is attached.
- 10 In one aspect the invention uses these two mechanisms 13, 14 to control its orientation and/or motion on the seabed. The first 13 incorporates front skids 2, which are fitted with soil penetrating fins 21, either the skids and/or the fins being rotatable with respect to the plough body. Steering mechanism 13 in figures 1 and 2 is formed by hydraulic rams 22 and skids 2 which can steer the plough even when the
- 15 plough is in an offset position. The second 14 incorporates an adjustable bridle mechanism or an adjustable towing mechanism for connecting to a bridle which in turn connects to a tow member such as a tow wire. The adjustable mechanism can be arranged in one embodiment to generate a steering couple on the plough with respect to the tow wire. In another embodiment, the adjustable mechanism is arranged to
- 20 reduce steering moments imposed on the plough from the tow cable, for example, to allow offset towing. The two adjusting arrangements 13 and 14 in combination can reduce the effect changes in the tow wire direction have on the plough whilst at the same time allowing ploughing, and indeed steering while ploughing, at larger offset angles.
- 25 Spaced skids 2 each carry a ground engaging fin 21 which generate side forces to steer the plough when these are at an angle with respect to the chassis 1 as shown in figures 3, 6 and 7. More than one fin may be provided on each skid. Typically the fins extend the length of the skids. The skids are rotated with respect to the chassis by
- 30 the action of hydraulic cylinders 22 in fig 3, 23 in fig 6 and 24 in fig 7. The fins may be rotatable with respect to the chassis 1 as well or instead of the skids.

Figures 3, 6 and 7 show alternative ways of adjusting the angle of the skids to steer the plough. In figure 3, the two skids 2 with the depth adjusting linkage 42 are mounted on transverse mounting beam 41 which is itself pivotally mounted on chassis 1 at pivot 40. The adjusting linkage 42 controls the height of the plough with respect to the skids as shown in figure 5. The skids are rotated in a substantially horizontal plane with respect to the plough by the action of rams 22 extending between pivoting mounting beam 41 and a second mounting beam fixed to chassis 1. Cylinders 22 angle the beam 41 and hence the skids.

10

In figure 6 the beam 41 in figure 3 is split to form two mounting beams 44A, 44B pivotally mounted to the plough at 35. Cylinders 23 rotate each beam independently to steer the plough about pivots 35. Two positions of skids 2 are shown at 31 and 32.

15 In figure 7 the hydraulic rams or cylinders 24 rotate only the skids 2 relative to a skid mount 37 from a position 33 to a position 34 around a pivot in the region of 36. These pivots may be in the form of slots, sliders or other means of achieving rotation. Rotation of fins relative to the skids is also possible although this is less preferable because of the exposure to damage of such a mechanism as well as the adverse forces
20 on the fins from the ground.

In figures 1 to 4 the tow rope 5 is connected to tow bridle 9 and this is connected to arms 25 at attachment points 25A. These arms 25 can rotate about pivots 26 about a generally vertical axis with respect to the plough under the action of hydraulic rams or cylinders 27. In figure 4 the arms 25 have been moved to accommodate the offset tow position of towrope 5. If the arms are not moved the bridle 9 would generate a steering moment on the plough because of the extra tension in one side of the bridle. The hydraulic rams move the attachment points 25A so that the centre of rotation of the bridle lies more or less above the centre of resistance of the plough ie above the
30 landsides of the plough share 3. In this way steering moments generated by the bridle are reduced. Steering can then take place by angling the skids 2 with fins 21 to allow

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the plough to follow the desired course on the seabed, or to allow for other side forces, for example from crossing a side slope. The arms can be moved to other positions to suit other offset tow positions on either side of the plough centreline. Of course the rams 27 can be used to generate a steering moment on the plough if
5 required, for example when crossing a side slope, particularly when offset ploughing across a side slope.

As can be seen from figures 1, 2 and 5 the towrope adjusting mechanism 14 formed by arms 25 and cylinder 27 is mounted on assemblies 28 that are mounted pivotally
10 on plough chassis 1. Assembly 28 can be rotated under the control of hydraulic cylinders 29. For normal operation the assembly 28 is positioned as shown in figures 1 and 2, and the plough is pulled along by the towrope 5. For lifting and lowering the plough to and from the seabed the hydraulic cylinders 29 can be operated to rotate assembly 28 about pivot 30 to the position shown in figure 5, so that the tow wire can
15 be used to lift the plough in an approximately horizontal position.

A benefit of having two pivoted structures 28 for lifting the towrope is that the hydraulic and instrumentation package 45 can be located above the central cable route, thus lifting it higher on the machine. This helps to keep the framework and its
20 contents out of the soil in very soft seabed conditions.

Figures 8 and 9 show bridle 9 connected via terminating chains 50 to hydraulic rams 27A. In this case rams 27A are substantially parallel to the longitudinal axis of the plough and these act to lengthen or shorten the arms of the bridle. The chains pass
25 through guides 50, which are optionally fixed to assembly 28. When guides 50 are fixed the effective attachment points of the bridle to the plough are located at guides 50 and do not change in position. In figure 9, chain 9A has been pulled through guide 50 to shorten the left hand bridle arm, thus allowing for offset towing to the right.

30 Figures 10 and 11 show front views of the plough in figures 8 and 9 in which assembly 28 has been rotated through pivot 30 to allow the plough to be raised or

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lowered or manoeuvred on the seafloor, over obstacles for example. In figure 11 both arms of the bridle have been shortened since chains 9A have been retracted through, in this case, fixed guides 50.

- 5 Figure 12 shows in plan view a Y shaped plough beam with forwardly fixed arms 25 to which guides 50 are mounted. Bridle arms 9 pass through guides 50 and are lengthened or shortened under control of hydraulic rams 27B. Figure 13 shows in plan view forwardly extending pivoting arms mounted to chassis 1 and rotated under control of hydraulic rams 27C. This arrangement is less efficient in lengthening and
10 shortening the bridle arms.

- Figures 14 and 15 show bridle 9 connected via terminating chains 50 to hydraulic rams 27A. In the case of figure 14, rams 27A are free to pivot relative to the plough and so effectively form part of the bridle arms; in figure 15, rams 27A are
15 substantially parallel to the longitudinal axis of the plough. In these cases, the chains do not pass through guides and in the case of figure 15, this can lead to substantial and undesirable bending moments on the hydraulic rams. These arrangements are considered to be less favourable than the arrangements shown in figures 8 and 9.

- 20 Figures 16 and 17 show two passive bridle adjustment mechanisms, i.e. mechanisms in which the adjustment of the geometry of the bridle is caused by changes in the direction of tow, but is not (or need not be) caused or assisted by active or powered mechanisms on the plough. In figure 16, the bridle limbs, or extensions of them in the form of chain 62 and cable or rope 63, pass through guides 50 and around
25 secondary guides or pulleys 61 and are connected together to form a closed loop. In figure 17, the bridle limbs 9 terminate on pivoting arms 25 that are restrained and coupled together by a rope, cable, chain or similar 60 that passes around guides or pulleys 61. The figure 17 arrangement has the advantage over the figure 16 arrangement that friction at the guides 50 is avoided. If a mechanism that is not
30 entirely passive is desired, the pulleys 61 could for example be powered.

CLAIMS

1. A plough comprising a plough share, one or more steerable soil-engaging fins and a tow rope attachment mechanism having a tow rope retention point; the tow rope attachment mechanism being adapted to enable adjustment of the position of the tow rope retention point relative to the plough, thereby altering the position at which the line of a tow rope retained by the tow rope retention point crosses the longitudinal axis of the plough, so that the plough can operate at a range of offset tow positions.
2. A plough according to claim 1 in which the tow rope attachment mechanism comprises releasable mechanical locking means for preventing the said adjustment from taking place.
3. A plough according to claim 1 or claim 2 in which the tow rope attachment mechanism comprises a bridle having two bridle limbs terminating at one end at the tow rope retention point and at the other at respective bridle limb retention points.
4. A plough according to claim 3 in which the tow rope attachment mechanism is adapted to enable the said adjustment of the position of the tow rope retention point relative to the plough by movement of the bridle rope retention points.
5. A plough according to claim 4 in which the tow rope attachment mechanism includes a pair of arms, each pivotable relative to the plough about a substantially vertical axis at its inboard end and providing a respective bridle rope attachment point at its outboard end.
6. A plough according to claim 5 in which the pivotable arms extend substantially laterally with respect to the plough.
7. A plough according to claim 5 in which the pivotable arms extend substantially longitudinally with respect to the plough.

8. A plough according to any one of claims 3-7 in which the tow rope attachment mechanism is adapted to enable movement of the bridle limb retention points relative to the plough from respective towing positions to respective lifting positions at which the bridle can be used to lift the plough in a substantially level attitude.
9. A plough according to any one of claims 3-8 in which the tow rope attachment mechanism is adapted to enable the said adjustment of the position of the tow rope retention point relative to the plough by adjustment of the relative length of the bridle limbs.
10. A plough according to claim 9 in which the bridle limb retention points comprise guides through which the bridle limbs pass and further comprising a pair of movable bridle limb attachment points to which the bridle limbs are attached.
11. A plough comprising a plough share and a tow rope attachment mechanism having a pair of bridle limb retention points, the tow rope attachment mechanism being adapted to enable adjustment of the relative length of a pair of bridle limbs retained by the bridle limb retention points, thereby altering the position at which the line of a tow rope connected to the bridle limbs crosses the longitudinal axis of the plough, so that the plough can operate at a range of offset tow positions, in which the bridle limb retention points comprise guides through which the bridle limbs pass, and further comprising a pair of movable bridle limb attachment points to which the bridle limbs are attached.
12. A plough according to any preceding claim in which the steerable soil-engaging fins are carried by one or more supporting skids.
13. A plough according to claim 12 in which the supporting skids are carried by a steering member pivotable relative to the plough about a substantially vertical axis.

14. A plough according to claim 13 further comprising means for adjusting ploughing depth by altering the vertical distance between the skids and the steering member.

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15. A plough according to claim 14 in which there are two or more skids and the vertical distance between one such skid and the steering member can be altered independent of the vertical distance between another such skid and the steering member.

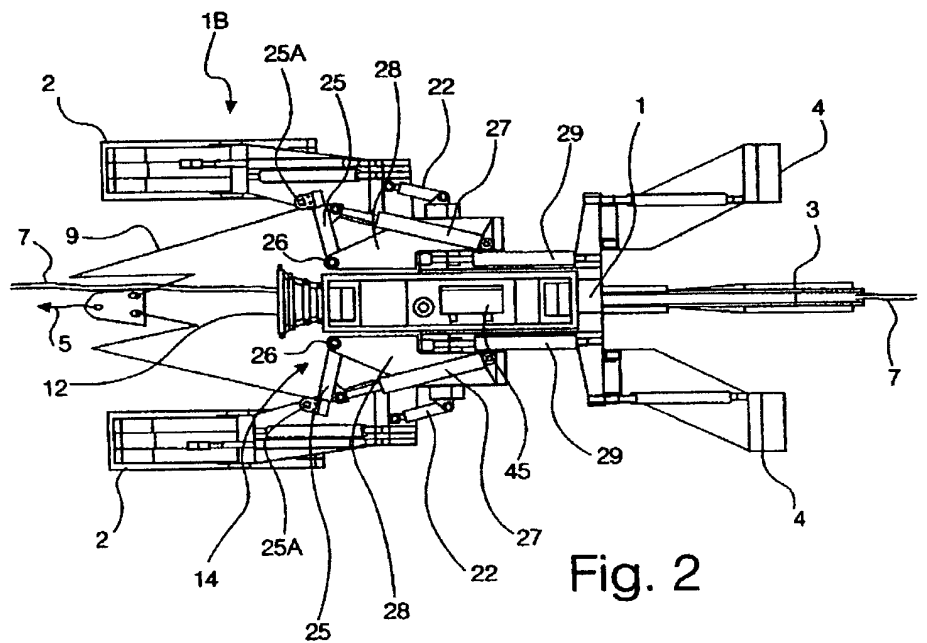
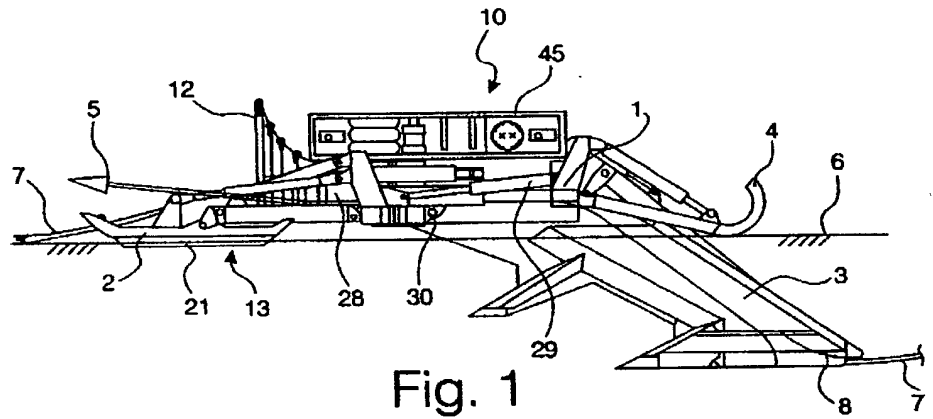
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16. A plough comprising a plough share and a tow rope attachment mechanism having a pair of bridle limb attachment points, the tow rope attachment mechanism being adapted to enable movement of the bridle limb attachment points relative to the plough, thereby altering the position at which the line of a tow rope connected to the
15 bridle limbs crosses the longitudinal axis of the plough, so that the plough can operate at a range of offset tow positions, and further comprising a mechanical linkage between the bridle limb attachment points such that movement of one bridle limb attachment point in one sense is accompanied by movement of the other in the other sense.

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17. A plough comprising a plough share and a tow rope attachment mechanism having a pair of bridle limbs, the tow rope attachment mechanism being adapted to enable adjustment of the relative length of the bridle limbs, thereby altering the position at which the line of a tow rope connected to the bridle limbs crosses the
25 longitudinal axis of the plough, so that the plough can operate at a range of offset tow positions, and further comprising a mechanical linkage between the bridle limbs such that lengthening of one bridle limb is accompanied by shortening of the other.

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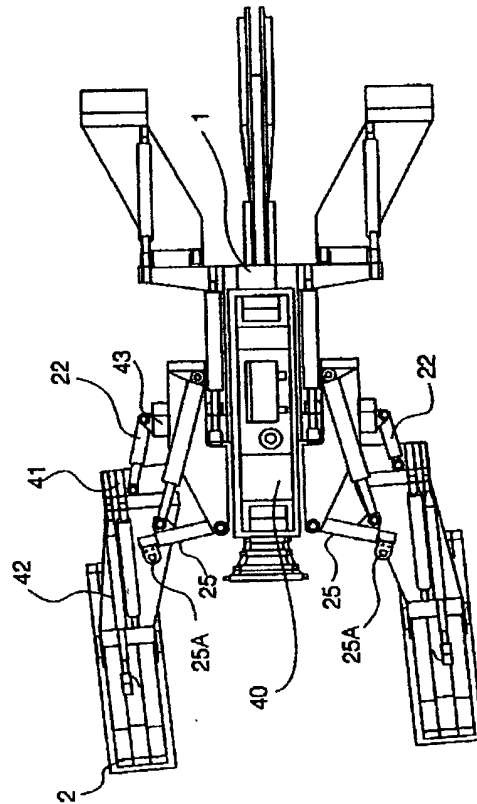


Fig. 3

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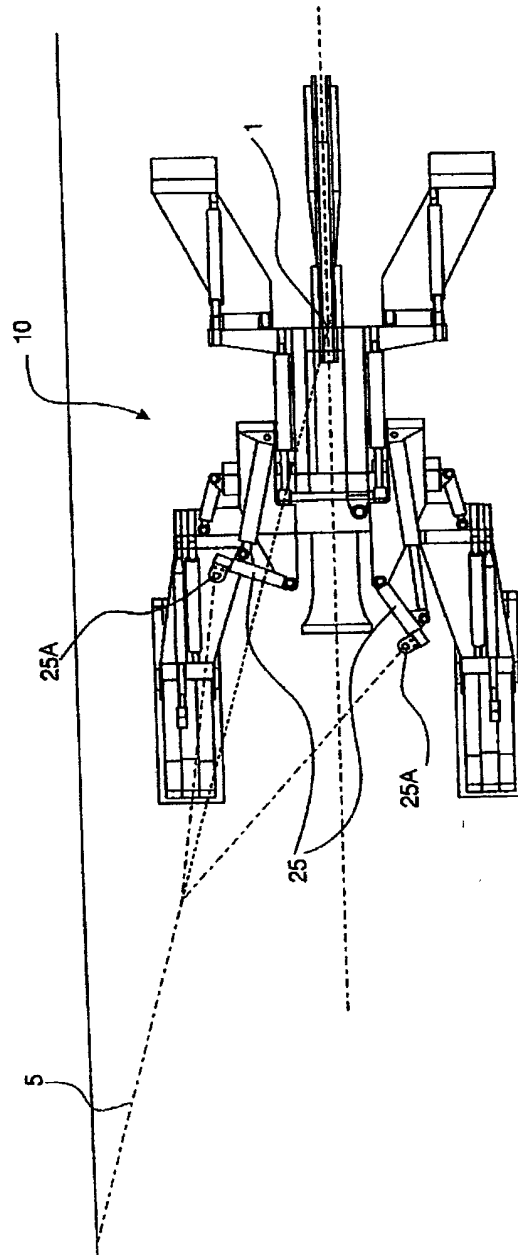


Fig. 4

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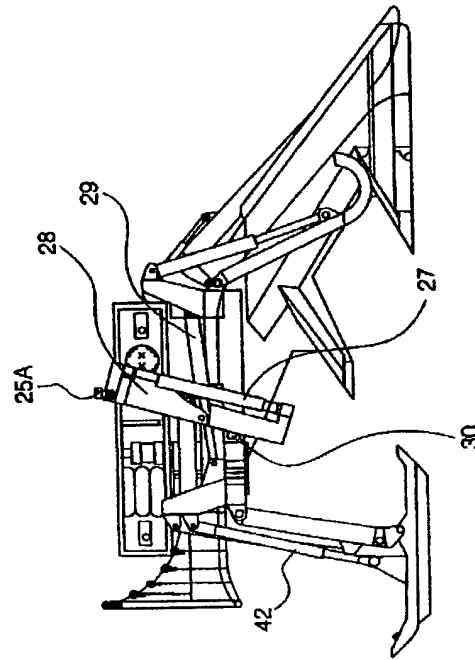


Fig. 5

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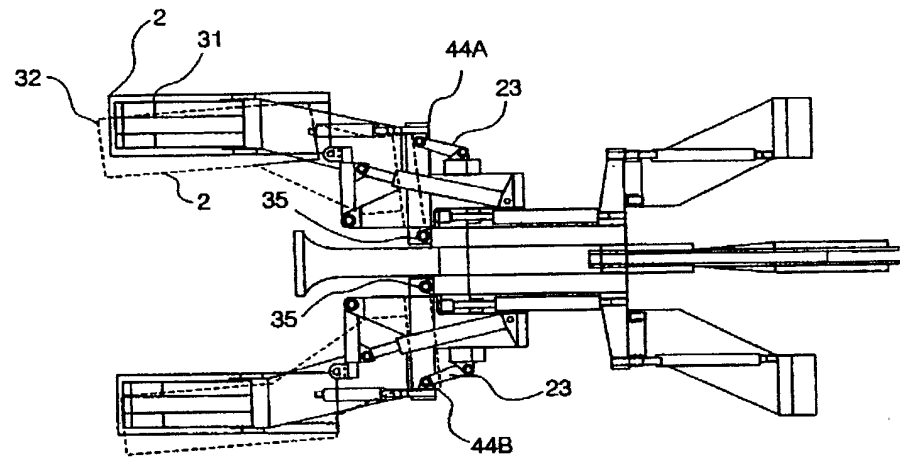


Fig. 6

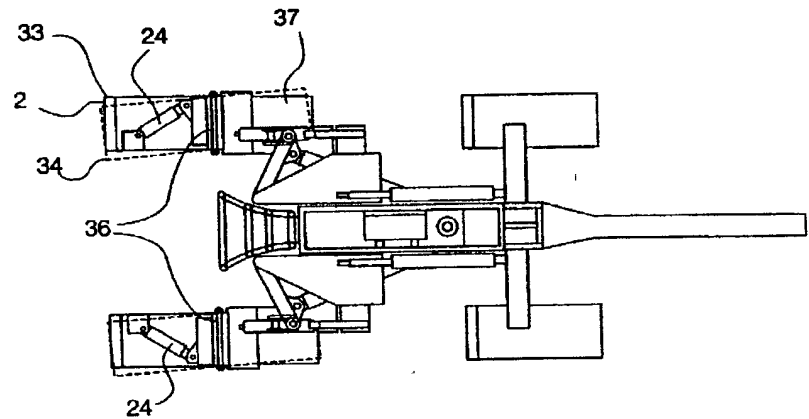


Fig. 7

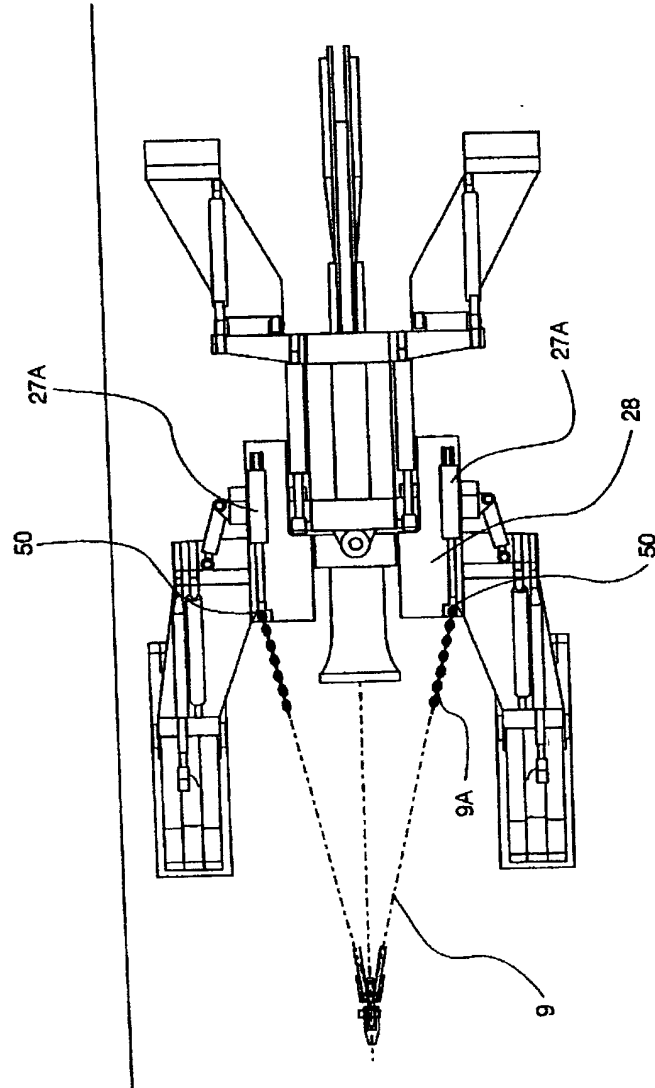


Fig. 8

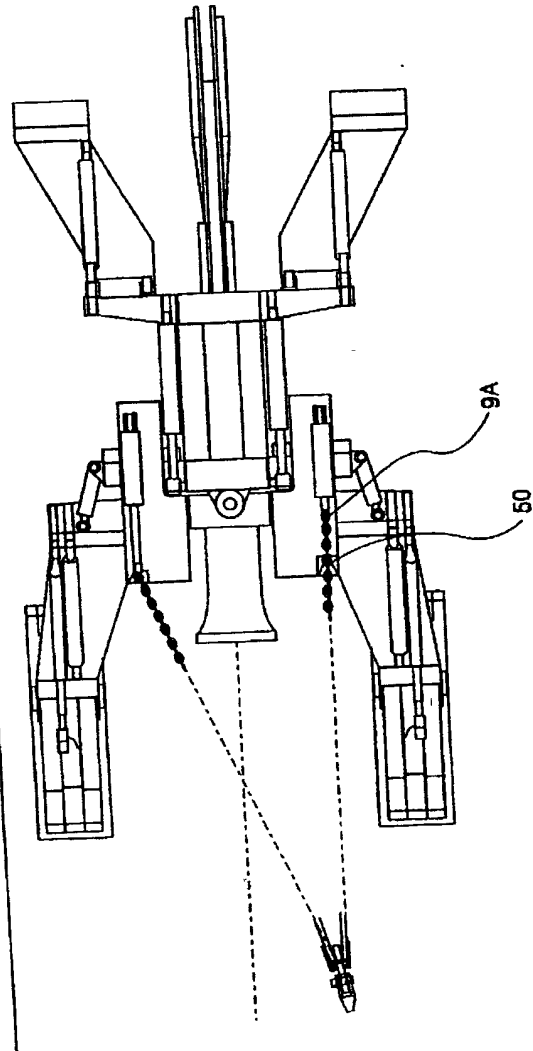


Fig. 9

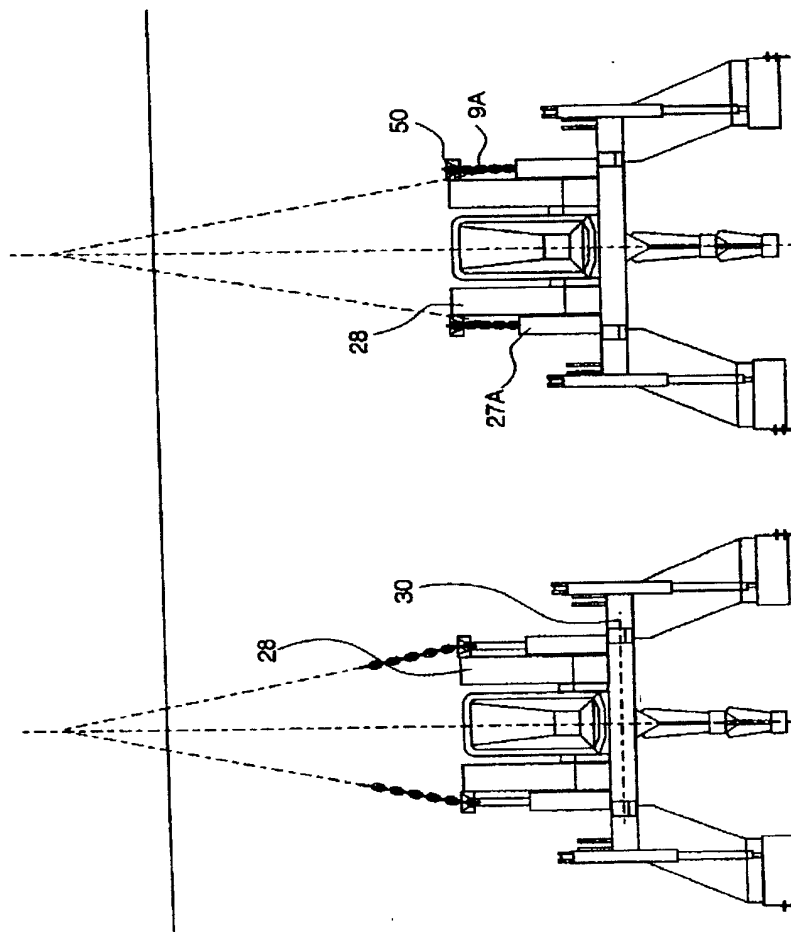


Fig. 11

Fig. 10

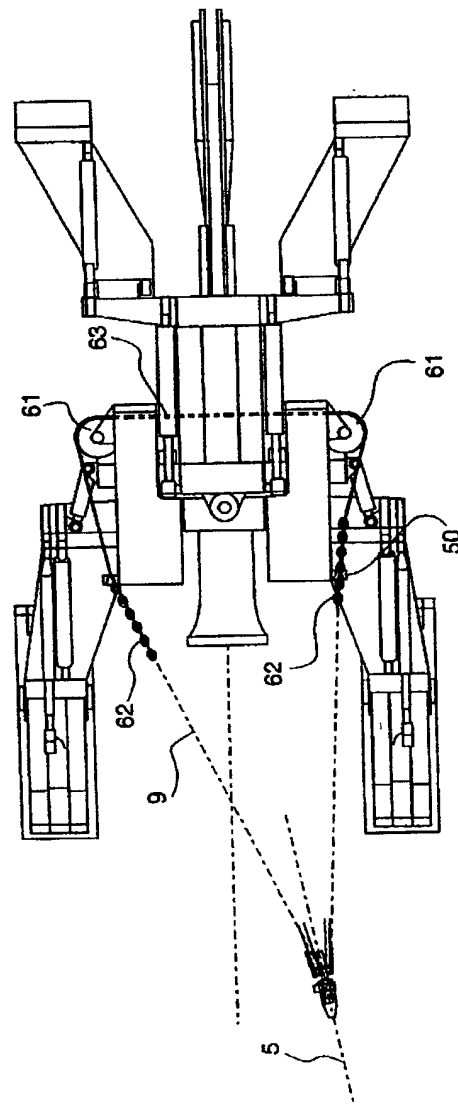


Fig. 16

SUBSTITUTE SHEET (RULE 26)

10089006-0522002
Rec'd PCT/PTO 22 MAY 2002
#4
10/089006

Applicant: Timothy William Grinsted
Serial No.: 10/ 089,006
Filed: _____
For: PLOUGHS

VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY STATUS
(37 CFR 1.9(f) and 1.27(c)) - SMALL BUSINESS CONCERN

I hereby declare that I am

☐ the owner of the small business concern identified below:

☒ an official of the small business concern empowered to act on behalf of the concern identified below:

NAME OF CONCERN The Engineering Business Ltd.
ADDRESS OF CONCERN Broombaugh House, Riding Mill
Northumberland NE44 7TN, United Kingdom

I hereby declare that the above-identified small business concern qualifies as a small business concern as defined in 13 CFR 121.3-18, and reproduced in 37 CFR 1.9(d), for purposes of paying reduced fees under Section 41(a) and (b) of Title 35, United States Code, in that the number of employees of the concern, including those of its affiliates, does not exceed 500 persons. For purposes of this statement, (1) the number of employees of the business concern is the average over the previous fiscal year of the concern of the persons employed on a full-time, part-time or temporary basis during each of the pay periods of the fiscal year, and (2) concerns are affiliates of each other when either, directly or indirectly, one concern controls or has the power to control the other, or a third party or parties controls or has the power to control both.

I hereby declare that rights under contract or law have been conveyed to and remain with the small business concern identified above with regard to the invention, entitled PLOUGHS by inventor Timothy William Grinsted described in

☐ the specification filed herewith
☒ P.C.T. Application No. PCT/GB00/03615,
filed September 21, 2000
☐ patent no. _____, issued _____

If the rights held by the above-identified small business concern are not exclusive, each individual, concern or organization having rights to the invention is listed below* and now rights to the invention are held by any person, other than the inventor, who could not qualify as a small business concern under 37 CFR 1.9(d) or by any concern which would not qualify as a small business concern under 37 CFR 1.9(d) or a non-profit organization under 37 CFR 1.9(e). NOTE: Separate verified statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities. (37 CFR 1.27)

FULL NAME _____
 ADDRESS _____
☐ INDIVIDUAL ☐ SMALL BUSINESS CONCERN
☐ NON-PROFIT ORGANIZATION

FULL NAME _____
 ADDRESS _____
☐ INDIVIDUAL ☐ SMALL BUSINESS CONCERN
☐ NON-PROFIT ORGANIZATION

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in the loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 C.F.R. 1.28(b))

I hereby declare that all statements made herein on my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

NAME OF PERSON SIGNING X TIMOTHY WILLIAM GRINSTED
 TITLE OF PERSON OTHER THAN OWNER X TECHNICAL DIRECTOR
 ADDRESS OF PERSON SIGNING X BEAUMONT HOUSE
STOCKSFIELD, NORTHUMBERLAND NE43 7TN

SIGNATURE X T.W. Grinsted DATE X 25th April 2002

Declaration and Power of Attorney For Patent Application

English Language Declaration

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

PLOUGHS

the specification of which

(check one)

☐ is attached hereto.

☒ was filed on September 21, 2000 as

PCT Application Serial No. PCT/GB00/03615

and was amended on _____
(if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)

Priority Claimed

<u>9922247.3</u>	<u>United Kingdom</u>	<u>21 September 1999</u>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
(Number)	(Country)	(Day/Month/Year Filed)	Yes	No
<u> </u>	<u> </u>	<u> </u>	<input type="checkbox"/>	<input type="checkbox"/>
(Number)	(Country)	(Day/Month/Year Filed)	Yes	No
<u> </u>	<u> </u>	<u> </u>	<input type="checkbox"/>	<input type="checkbox"/>
(Number)	(Country)	(Day/Month/Year Filed)	Yes	No

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Serial No.)

(Filing Date)

(Status)
(patented, pending, abandoned)

(Application Serial No.)

(Filing Date)

(Status)
(patented, pending, abandoned)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (list name and registration number)

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Full name of second joint inventor, if any	
Second Inventor's signature	Date
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Post Office Address	

(Supply similar information and signature for third and subsequent joint inventors.)